Space Weather Technical Forecast

Issued on Saturday, 09 July 2022 at 13:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further M flares and R1 Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose sharply to become Moderate in the past 24 hours, with a long-period M2.5 X-ray flare recorded at GOES16 from AR3053 at 08/2048UTC. Background activity level is now slightly higher than it was 24 hours ago.

There are five sunspot regions on the visible disc. The largest and most complex one remains AR3053 but AR3055 is also growing in size and complexity, whereas the other groups are smaller and simpler.

There are currently numerous large filaments on the disc, with the southeast quadrant in particular harbouring two large features that each span roughly 20 degrees on the solar disc. There were no signs on instability in these in the reporting period, however they will become increasingly relevant should they lift off in the coming few days and will be monitored. Other areas of note included the southwestern limb, which saw a non-Earth directed prominence lift-off.

The large M-class flare was a long-period one and showed some dimming in AIA 211, both of which often precede the release of a Coronal Mass Ejection. A CME was indeed visible on satellite imagery but its analysis revealed that it is not Earth-directed and passing East of the Sun-Earth line. No Earth-directed CMEs have been observed in available imagery over the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, showed some residual CME influences initially, followed by a SSBC and a return to a nominal regime. The solar wind speed decreased from 410 to 350 km/s. Its density was somewhat erratic but largely average, although it did peak at 16 ppcc for a time between 08/1900-2100 UTC. The IMF was Moderate initially, with a peak of 12nT around 08/1200 UTC, but became slowly weak over time. The north-south component was varying very weakly but became strongly positive, up to +8nT, when the phi angle, which has been largely positive (away from the sun), became negative (towards the sun) between 08/1830-2400 UTC. The net effect of the above solar wind measures was an overall decreasing geomagnetic activity, from Quiet and Unsettled to increasingly Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES-16, remained at Background levels throughout the period.

The high energy electron flux (greater than 2MeV) has been at Normal Background levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold on a roughly level trend. Observed fluence was 1.45e6 integrated pfu at 09/0001UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain Low, but with a daily Chance of M-class flares. A progressive slight increase is possible in the four days, as while no significant regions leave, up to two may return over the eastern limb.

Solar Wind / Geomagnetic Activity: The glancing blow that was expected from the CME that left the Sun on 05 July is now considered very unlikely. No other CMEs feature in this forecast. Solar winds are expected to be slow-ambient initially, before becoming slightly elevated on day 3 or even elevated on day 4, under the influence of the high speed stream from CH99/+. Geomagnetic activity should therefore be largely Quiet with the odd Unsettled interval on days 1 and 2 (09th and 10th), but Quiet to Active on days 3 and 4 (11th and 12th) with a Slight Chance of a G1/Minor Storm on day 3 (11th), at the onset of the HSS from CH99.

Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is likely to remain at Background levels, but with a very slightly rising tendency with the westward progression of the front-side large sunspot groups.

The high energy electron flux (greater than 2MeV) may increase at the end of this period but the corresponding fluence is is expected to remain well below the Active threshold (1e8 integrated pfu) while exhibiting a slight rising trend at best.

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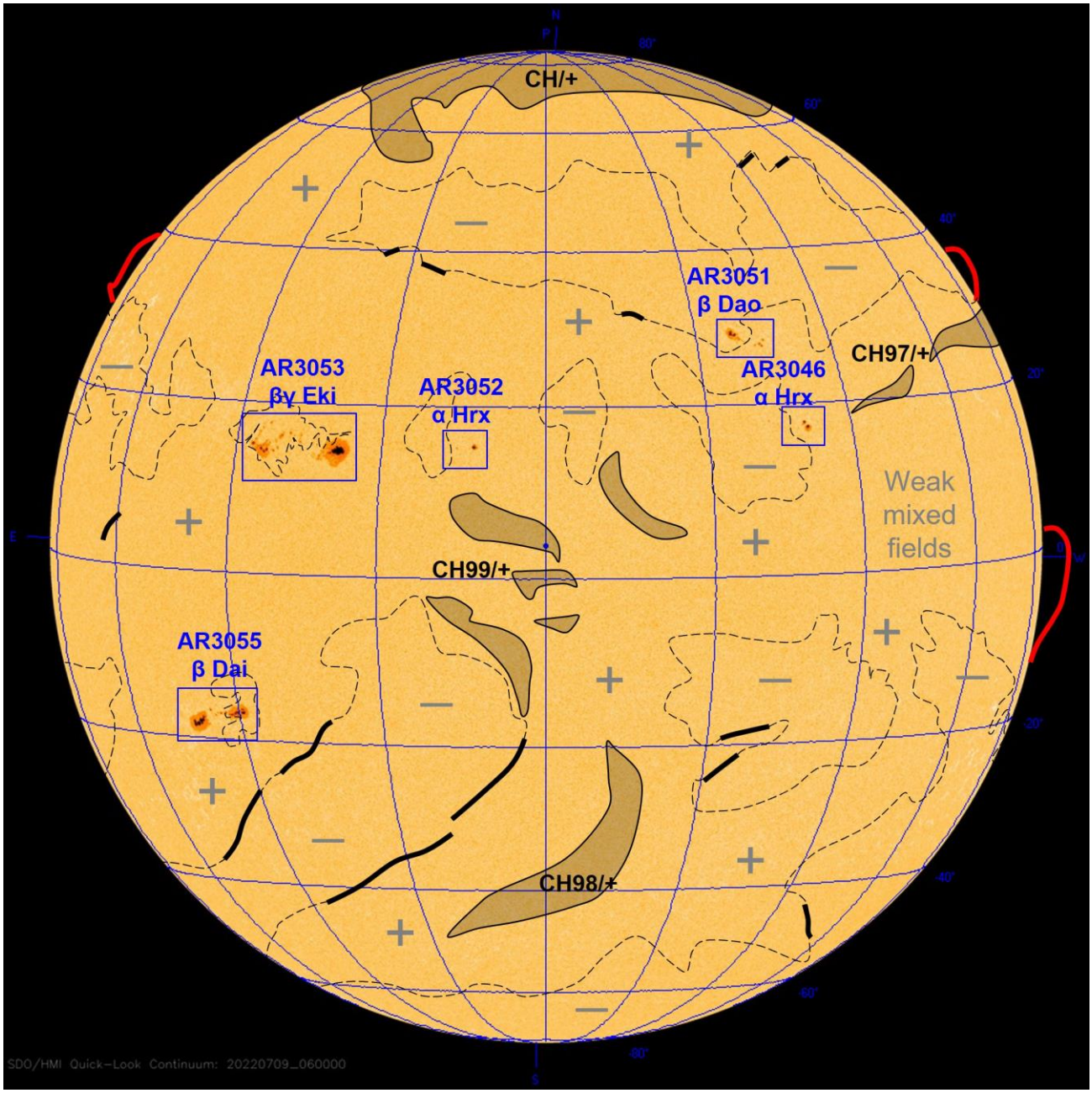
Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The glancing blow that was expected from the CME that left the Sun on 05 July is now considered very unlikely, the CME having most likely passed well ahead of Earth. In addition to this, the CME from the 08 July M2.5 flare, originating from AR3053, has been analysed as passing to the East of the Sun-Earth line. No other CMEs feature in this forecast.

The solar wind parameters are now exhibiting a slow regime, with no more influence expected from CH97. The next coronal hole worth of note is the very fragmented CH99. It is a recurring feature that generated speeds of 600 km/s on the previous rotation however, due to its smaller size and split shape, it is hard to believe that such velocity will be achieved this time around. STEREO A does show an enhancement in the early hours of today, associated with a positive phi angle, which may indicate the arrival of the HSS from CH99/+. This would correlate to an arrival at Earth on day 3 (11th), which would be 24 hours earlier than expected if we consider the SWPM, but possible. CH98/+ may contribute to the solar wind increase on days 3 and 4 however its input is considered minor, being further away from the Earth ecliptic latitude. Estimated solar wind speeds are for 400km/s on day 3 (11th), perhaps reaching 500km/s on day 4.

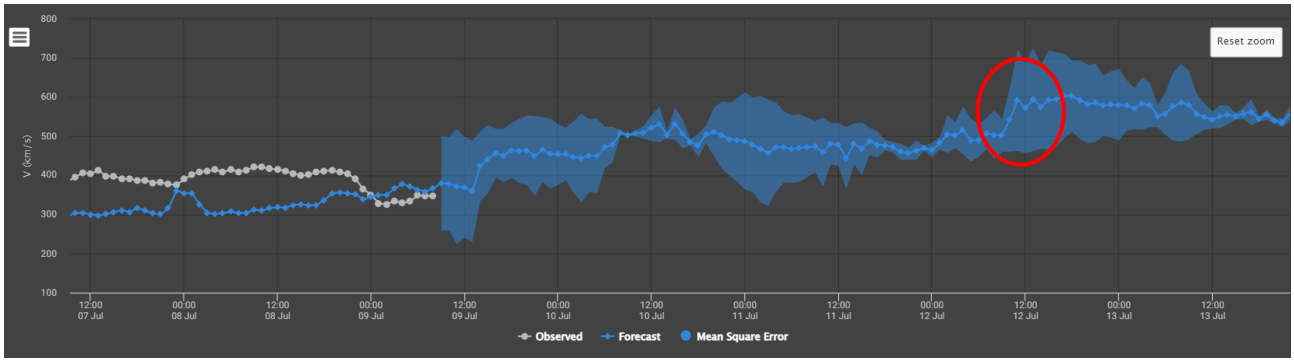
Geomagnetic activity should therefore be largely Quiet with the odd Unsettled interval on days 1 and 2 (09th and 10th), but Quiet to Active on days 3 and 4 (11th and 12th) with a Slight Chance of a G1/Minor Storm on day 3 (11th), at the onset of the HSS from CH99.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

NIL

Figure 2: SWPM, expecting the HSS from CH99 on the 12th – considered too late.



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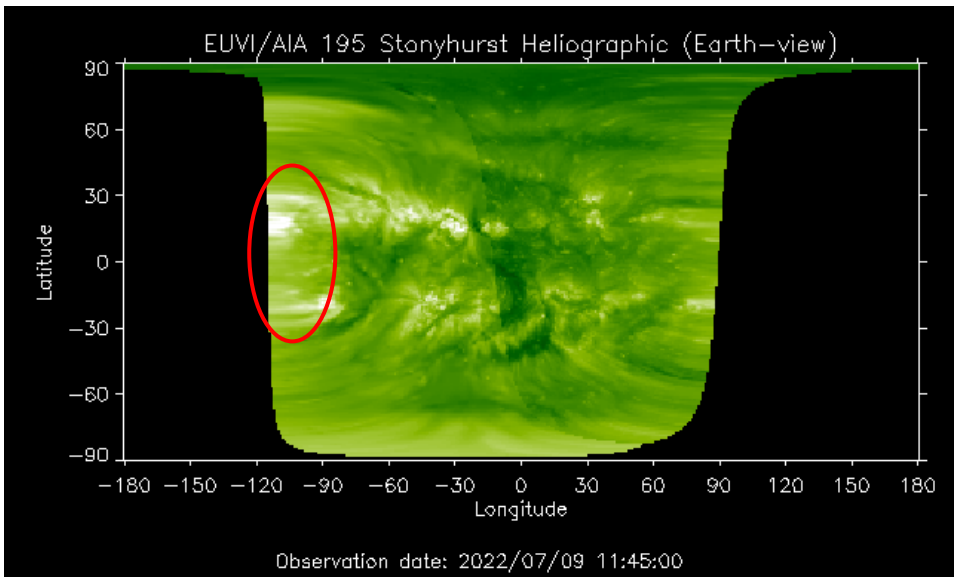
Radio Blackouts - X-Ray Flares:
There are five numbered sunspots on the disc. AR3053 remains the largest and most complex region. A couple of penumbrae have disappeared from the trailing group but some additional spots have appeared in the intermediate group, some showing a rudimentary penumbra. It's also slightly more complex magnetically, requiring a change of classification, now Beta-Gamma. The other region worth of note and also growing in size is AR3055 in the southeast quadrant. It is spreading longitudinally with the emergence of several specs in its intermediate group. AR3051 is now a mature and stable region, with no significant changes or growth. AR3046 and AR3052 are both simple and unipolar groups, with no significant changes or growth.

Solar activity was Moderate, with an M2.5 from AR3053 at 08/2048UTC. This remains the most likely source of further activity, with other regions producing only minor C-class activity thus far. Probabilities have been reviewed slightly upward, due to the recent developments of AR3053 and AR3055.

Bright flux regions are also visible on EUVI/AIA-195 imagery, indicating the presence of plages or active regions near 110 degree East. These may potentially rotate off the northeast limb on day 2 and day 3.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Cylindrical projection of the sun in 195 Angstroms, showing impending bright flux regions Around 110 degrees East, suggesting further emerging sunspot regions in the coming days.



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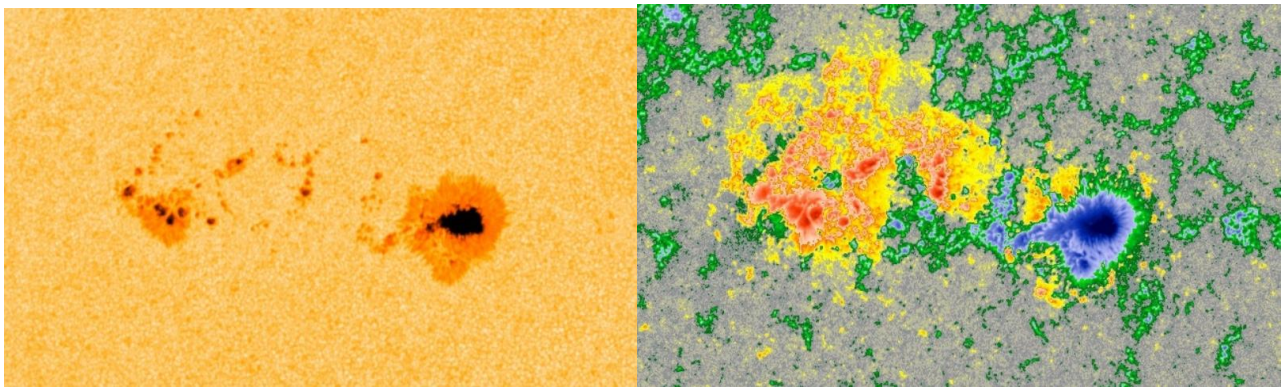
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently at Background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development.

There is a very slight upward tendency in risk through the four days, however this is not sufficiently different from the 5% shown to display.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO hmi-intensitygram and magnetogram of northwest disc, showing AR3053, the largest and most complex region



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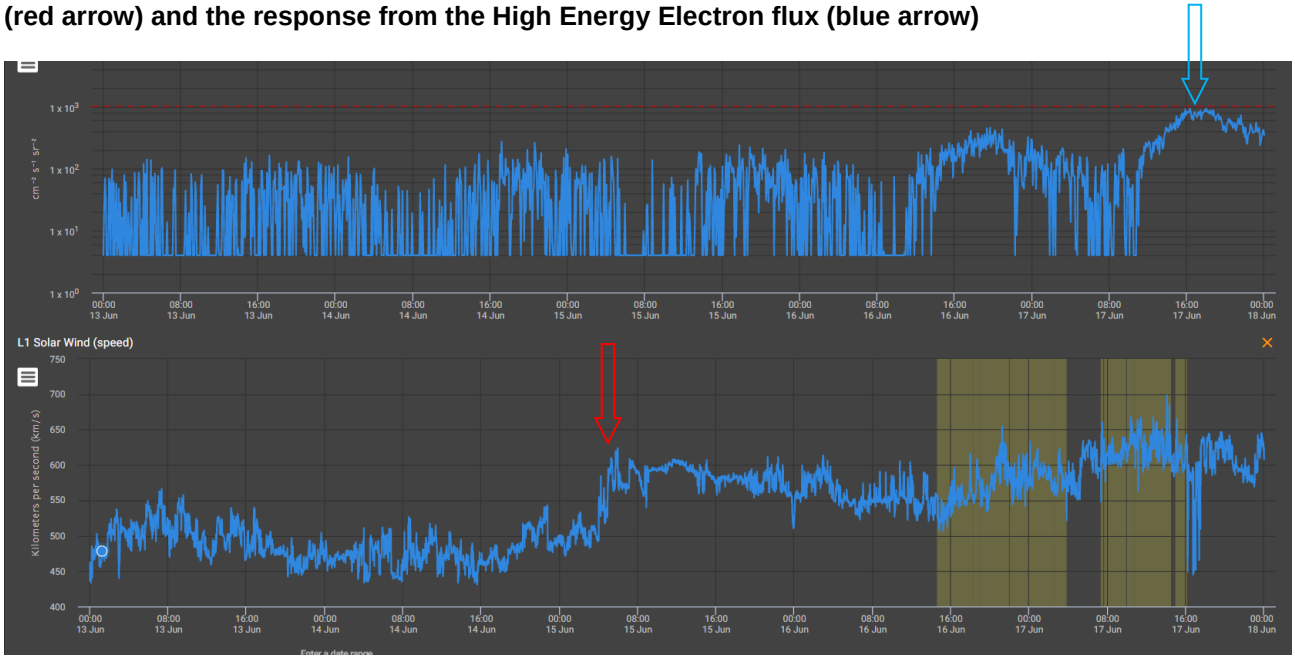
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) is currently at Normal Background levels. Recurrence methods are not likely to be useful in the forecast given the changes in CH97/+ and its predecessor between rotations. The expected arrival of the next HSS will most likely prevent any significant increase on day 3 (11th). Flux levels may increase on day 4 (12th) but data obtained from the previous rotation indicate that the rise was slow and only exceeded high levels after several days, way beyond this forecast period.

The corresponding fluence is likely to exhibit a slight rising trend at the end of this period but is very unlikely to exceed the Active threshold (1e8 integrated pfu).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: Data from previous rotation showing the important time lag between the arrival of the HSS (red arrow) and the response from the High Energy Electron flux (blue arrow)



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